

HIGH PERFORMANCE ADOLESCENT TENNIS PLAYER LONGEVITY

CREATING A ROBUST TRAINING ENVIRONMENT

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There are different roads to a successful performance, however including both evidence from research and on court experience is most likely a very smart move to make, no matter what road you choose to travel on. However, to be able to take that integrated approach, the team working with the player needs to be well-informed, open-minded and be ready to adjust daily to the changes that take place in the environment. In view of the adolescent player even more things come into play such as growth, maturation, and mental abilities, all taking their individual road of development. Therefore, to create a sustainable road with the adolescent player is in many ways a more complex task than developing and managing the adult professional player.

In this article the primary aim is to present an overview of long-term player development using a practical

and sustainable approach, with special emphasis on the high-performance player.

WHAT DOES SCIENCE TELL US ABOUT LONG-TERM ATHLETE DEVELOPMENT?

In view of high-performance and adolescents we need to remind us daily that adolescents are not fully grown professionals and therefore we cannot perform a scaled down copy-paste strategy from the professionals' training regime. However, we also need to remind us that although on one hand we have a lot of time with an adolescent player, we cannot postpone training, be unprepared nor be without a clear mindset of what we want them to achieve.

Long-Term Athlete Development models

There are different models of long-term athlete development presented in

literature¹. One of the first youth athlete development models was described in 1999 by Cote, based on a small sample of athletes and interviews. It was a good initiative, but to provide a more solid base, a more comprehensive approach was needed. In 2004, Balyi and colleagues presented the nowadays established long-term athlete development model (LTAD) which is based on biological growth and development by using peak height velocity (PHV) to determine readiness for each training stage. Also, in the LTAD model sensitive periods or “windows of opportunity” are something that has gotten a lot of attention. Although it may hold true, in a real world setting we need to be careful, so players and coaches do not misunderstand and think that if they miss a “window of opportunity” that the chance of developing a specific skill is lost forever. Lastly, in 2012, the youth physical



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development (YPD) model proposed by Lloyd and Oliver also emphasized a development-based over aged-based approach. However, compared with the LTAD model, YPD provides a more detailed scheme of what type of training should be emphasized during each developmental stage, also with regards to male and female athletes.

These models have on one hand revolutionized the approach of the young athlete and how we approach long-term development. On the other hand, some sports (including tennis) require a lot of skill training at an early age due to the complex

technical demands of the sport. Therefore, it takes a lot of patience and knowledge to follow these models, and it may need some modification due to the specific demands of tennis such as the competition schedule.

Competition schedule and its effects on long-term player development

Tennis at a professional level is one of the most challenging sports in view of prevention and performance due to a variety of factors. First, the competition schedule is very intense throughout the calendar year with very few periods of long-

term recovery. Second, the system within itself encourages players to compete almost every week in pursuit of ranking points to reach the next level. Lastly, due to the above, the timeframe for working on prevention and performance is narrow and therefore the knowledge, planning and structuring of sessions become crucial to stay healthy, and free from injury.

Although the adolescent player is not a professional player and potentially could take time off in the competition schedule, it is less likely to happen because the system is based on the professional tour level; the ITF junior system operates by ranking points across different levels of tournaments, with more points awarded at higher grade tournaments and thus Grand Slam Junior events being the most prestigious.

Therefore, intense travel, playing between 20-30 tournaments and 100-120 singles matches in a 12-month period is not uncommon, and most likely needed if the player wants to increase the ranking. With those numbers the training and competition load is immense from an early age on, and the long-term health of the adolescent player may be de-prioritized and the injury risk enhanced².

Early specialization in tennis

Early specialization does not necessarily need to be all bad, but to be sustainable it needs an environment that is very player-centered and possess a high degree of knowledge within the team around the player. In a setting with early specialization the risk of burn-out and/or injury is higher, especially during periods of intense growth, which may reduce the possibility of long-term success³.

To be proactive with the adolescent player choosing early specialization, a sound model of load management is helpful. Such a model has been presented, dividing the players into load sensitive, naive, and tolerant athletes⁴. This approach gives a broader view of growth and maturation and if used wisely it may reduce the risk of injury from a long-term perspective. The high weekly training load that is needed in tennis is not within itself a risk factor, but the challenge is to get there safely. Previous studies have highlighted the risk of injury by stating the “too much, too soon” concept², therefore we need to start building the players early, and year by year increase training and competition load in a

controlled manner. That road is not an easy one and all players have their individual rate of growth and maturation. To support decisions along that road bio-banding has been successful in some other sports and may be helpful also in tennis to keep players in the safe zone with relation to overuse injuries⁵.

In addition, the understanding of early versus late entry into puberty is helpful in the long-term development of the tennis player. It has been shown in ice-hockey that the late maturer to a greater extent reached the highest level⁶.

LOAD MONITORING IN ADOLESCENT TENNIS PLAYERS

The foundation of training monitoring is to evaluate intensity, duration, frequency, and sport specific activities. Monitoring of training load has become more and more common, and there is growing research in the field and its association with injury risk⁷. Furthermore, tennis players' optimal training progression can be supported by reliable and valid monitoring tools such as GPS, heart rate monitoring watches and/or other devices⁸.

Training load is most often defined as either internal load which refers to measures like session RPE, heart rate, and blood markers such as lactate, creatin kinase, and cortisol⁹. Another possible option for internal load measurement that has strong evidence, would be represented through heart rate variability (HRV), which is a measurement of the variation in time between consecutive heartbeats. This method can provide more insights into the athlete's recovery status and intensity of the training.

External load refers to the actual load on the athlete such as kilogram lifted in one session per muscle group, meters covered in a training session, and/or number of directional changes⁹.

Wearable technology

A valuable support to provide specific measurements for coaches and/or players in their strive for optimal performance is to use wearable technology⁸. In tennis, it is of high importance for example to understand how much load has been put on the player in the on-court setting in terms of distance, change of direction and number of shots being performed. Also, the intensity of the on-court sessions is of great importance to

be able to plan the off-court sessions in an optimal way.

In summary, there are many advantages to using wearable technology, but to be able to maximize the information from the wearables, knowing how to interpret information relative to tennis is a crucial factor, and not all teams have this option available.

However, for those unfamiliar to load monitoring, or those not having access to wearable technology or other devices, a practical and cost-efficient method in the field mainly with adolescent players is to use a 3-step load monitoring model including volume, intensity, and arbitrary units (AU).

Volume

Of all the different ways of load monitoring, registering training volume in hours is the most basic step. Although it takes a lot more than just keeping track of hours to be able to draw any major conclusions, it could be a first step to bring the player and the coach on board. Furthermore, it can be useful to monitor quantity since many sports (including tennis) demand a relatively high training load from an early age on. A tennis player trying to reach high levels of competition is expected to practice 15-20 hours of tennis per week plus strength and conditioning training. Therefore, monitoring total hours of weekly training is needed as the basic first step.

Intensity

To complement volume, the next step is intensity, to understand how much the sessions "cost" in terms of metabolic demands. The easiest way to monitor intensity would be to use the session Rate of Perceived Exertion (RPE) number between 1-10¹⁰. It is important that to assess the RPE 30 minutes post practice, otherwise the rating may be biased by the last exercise performed in the session. Furthermore, the RPE rating of 1-10 is an understandable and easy assessment for most adolescent players, and over time they become self-educated, more precise, and honest in their rating.

Arbitrary units (AU)

A session's training load can be expressed by multiplying training volume and intensity, to provide a total score in arbitrary units (AU). For example a 90min tennis training session with a recorded RPE of 7 gives you a

training load score of 630 AU. That number does not say much if you estimate one session, but over time and if continuously registered it becomes a training tool that is very helpful. For example, either in terms of designing intense periods of training, trying to adjust the load, or if injury occurs as a guide in return to play.

With adolescent players and coaches, these 3 steps can be sufficient to help monitor training load. And like all monitoring, if you do not analyze and work with the numbers, the monitoring becomes unnecessary information.

TRAINING VOLUME – PREVENTION AND INJURIES

For many decades the discussion about training volume and its relation to injuries has been debated by the scientific and medical team in search of finding the optimal load. Of all things that can happen on the negative side, long-term injury is one of the most challenging ones. On one hand, prevention is getting more and more attention in the total training plan. On the other hand, coaches and players are less willing to perform prevention training, instead wanting to push the boundaries and practice more intensely, in the chase for improved tennis specific skills and winning titles. The truth is most likely found somewhere in between and very dependent on the individual athlete and the resilience from the athlete both physically and mentally.

SUDDEN CHANGES IN TRAINING – SPIKES AND OVERUSE INJURIES

Increasing the training volume is an easy intervention and can be performed by anyone, and its short-term result is often very positive. However, to build sustainability and long-term performance in a player other aspects need to be considered, such as evidence-based knowledge, experience and integrated on-court sessions.

Rapid changes in training volume have been investigated in different sports to a relatively great extent and although methods do vary between articles, a consensus is so far that these rapid changes may be a potential risk for injury. In tennis there have been fewer articles, but the result is in line with previous literature, highlighting an increased risk for injury if rapid spikes occur within the weekly training load⁹. The interpretation

of these articles to a practical setting is that the load should be consistent from week to week, and slowly increase over time to build a robust player. However, increasing training load gradually is needed for development. Based on author's experience a 10-15% increase from year to year in volume is probably a safe recommendation in the 12-19 year old age groups.

LTAD and injuries

One topic that is not as clearly addressed as others in the LTAD concepts is injury and how we either prevent or manage injury in the adolescent athlete, and how that subsequently affects their long-term development. The LTAD model presupposes that you progress from one developing phase to another, outlining a best-case scenario. However, very often adolescent players are not on track due to many different reasons such as injuries, mental health challenges, growth, maturation, and other challenges.

It could be a minor injury that requires short term leave, but it could be several minor injuries that in the end add up to a quite long time of absence. On the other hand, it could also be a major injury such as a stress-fracture that needs longer periods of rest and recovery. In both cases the LTAD model (and its different phases) is to a minor or major extent disrupted, meaning that the player and coach need to adjust the arrival date of the destination. An adjustment not only including taking load off the player but also considering that the development of different skills most likely will be delayed, and therefore demanding a lot of patience from the team around the player.

BIOMECHANICS, MOVEMENTS, AND STRENGTH FROM A PREVENTION AND PERFORMANCE PERSPECTIVE.

In terms of prevention and or performance in tennis, the discussion about technical proficiency is not getting enough attention. In a sport like tennis, repetition on-court is the key, and if the movement pattern is not functioning almost to a perfect standard the structures of the body will need to compensate. In addition, the strokes are performed at high speeds, generating forces in all planes of movement. Therefore, if the technique is poor and inefficient, the different structures of the body such as the tendons, muscles and bones may be overloaded, which could lead to injury.

To better understand how much repetition takes place, we used GPS-tracking with a Catapult device (Tennis module) to quantify the load of two high-performance female players during a 2 hour-session on clay, mostly performing different drills from the baseline. The session was repeated 3 times the same week and the numbers were on average 900 groundstrokes per 2-hour session. Extrapolated into one year of tennis in an adolescent 15-year-old player being on-court ± 15 hours we end up at 300 000 plus strokes per year. That gives us an idea of how

important the mechanics are both from a prevention and performance perspective.

With such a high volume of tennis stroke repetitions it will be an almost impossible task to balance that in the gym with prevention exercises. However, one solution is to work closely together on court targeting specific biomechanical aspects of the different strokes. As presented in literature by Kovacs and Ellenbecker in the 8-stage serve model¹², the player could benefit a lot from a team of competences when evaluating the serve biomechanics.



Image: Illustration of the serve – reproduced with permission.

For example, how the loading phase of the serve not only build power and speed but also by using the kinetic chain from legs up actually take load off on the upper extremities such as the shoulder, elbow and wrist¹³.

Strength

One big challenge in tennis is the performance of strength training. We know from studies that strength in general has a positive effect on health parameters. In addition, the consensus statement from the national strength association highlights the fact that strength is supportive in the learning process of different motor skills. Furthermore, tennis players are not an exception, meaning that if we prescribe strength training, they will respond in a positive way.

In a LTAD setting we know there are evidence-based guidelines outlining the path in view of how we can or should load young players. Integrating the tennis competition schedule into that model is a challenge, since competition starts at an early age and continues to be relatively frequent throughout adolescence. To be able to protect the body and build resilience, the tennis player should also start earlier with general strength training to improve tissue tolerance to load, possibly preventing potential overuse injuries. Figure 1 demonstrates a way of integrating tennis volume and strength training during a 13-week period.

THE SHOULDER PERSPECTIVE – A LOCAL PARAMETER OF STRENGTH

In view of the shoulder there are many considerations to discuss such as local strength and flexibility mainly in the rotator cuff and biceps, as well as global strength including the legs and core, and the ability to generate force using the kinetic chain¹³.

Shoulder strength - How strong do you need to be?

The shoulder strength has been evaluated extensively, mainly by isokinetic assessments first, and later by hand-held dynamometry¹⁴. In general, the shoulder as a local contributor to efficient mechanics needs to be highlighted. Furthermore, the shoulder is one of the most affected body parts in tennis, especially vulnerable in the high-speed forehand and service motion. Despite all the assessments the question

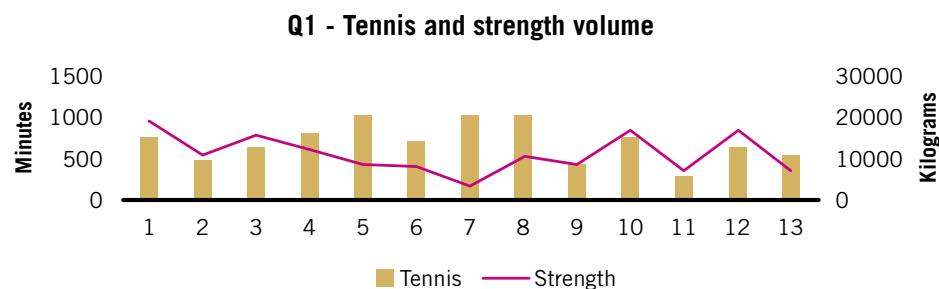


Figure 1: The interaction between tennis volume and strength during one quarter (13 weeks). When the tennis load (in hours) is high, the load in strength (kilograms lifted) is less and vice versa. In some weeks tennis and strength are almost equal in load (week 9) and the differences between the weeks is a good base for discussion within the team.

seems to remain, how strong is strong enough?

As presented in the study by Johansson et al¹⁵, percentiles were used to divide players in different groups which may be a more clinical approach than just one number answering the question if you are strong enough. Also, when normalized to body mass, the study by Johansson et al shows sex differences such as the strength values of the female players are leveling out comparing the age group 14 years and under with the age group 15 years plus, whilst male players still increase their relative strength throughout adolescence. Furthermore, although you may be strong in external rotation (1.5-1.8N Normalized to Body Weight) and internal rotation (2.3-2.6N Normalized to body weight) based on the Johansson et al study, we must also include general strength to get the full picture of shoulder robustness. Based on unpublished data on tennis players and experience a value in shoulder press would range from 0.4 to 0.75 and 0.4 to 0.6 of bodyweight for 1 RM for male and female players respectively during the ages of 14-19 years of age.

In summary

Natural physical characteristics for a player are advantageous but establishing a robust training environment where players train to be able to train, then train to be able to compete, will be a smart journey to travel on.

HOW TO GET GOING WITH A LONG-TERM DEVELOPMENT PLAN?

- Integrate research with on-court experience for optimal development

- Have a clear long-term goal within the team
- Balance training and competition schedules effectively to maximize long term development
- Load management is key, use the 'load sensitive, naive and tolerant' model
- Monitor volume, intensity, and arbitrary units as a basic first step
- Build chronic workload over time and avoid rapid changes (spikes)
- Be patient and adjust if injury occurs
- Use biomechanics to your advantage
- Prioritize strength, build globally (legs, core), protect locally (shoulder)
- Train to be able to train, then train to be able to compete.

To be able to protect the body and build resilience, the tennis player should also start earlier with general strength training to improve tissue tolerance to load, possibly preventing potential overuse injuries.

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